Space Weather Technical Forecast

Issued on Friday, 22 December 2023 at 01:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-class flares throughout. Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a M4.2 flare observed at 21/0538 UTC and a M3 flare at the very end of the period, both from AR3519 in the southwest quadrant. There were also a number of energetic C-class flares during the period. AR3519 has been the main source of the C-class flare activity, but AR3529 has also contributed. This region is a large, dominant, magnetically complex region in the southeast quadrant and is currently classified as Ehi/beta-gamma. AR3519 Cai/beta-gamma, plus AR3528 Dai/beta in the northwest, are the most notable of a total of nine regions on the visible disc, with the remaining regions either simple or largely inactive

The second M-class flare from AR3519 appears to have also produced another CME, but this is considered unlikely to be Earth directed, as the CME analysed and modelled from the earlier M-class flare is expected to miss Earth. However, analysis and modelling will be undertaken on the second CME to confirm this.

Solar Wind / Geomagnetic Activity: Solar wind speeds have steadily declined from 490km/s to around 350km/s as the Earth exits the high speed stream from coronal hole 82. Density has been below average to average. Total magnetic field strength, Bt has been weak, with the north-south component, Bz varying weakly. Phi angle has been mainly positive (away from the Sun), with a brief morning incursion into the negative sector. Total geomagnetic activity has been Quiet to Unsettled (Kp 0-3) throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux has steadily increased from moderate levels to either close to or just above the high threshold (1000 pfu), with a peak of 1273 at 21/1820 UTC. The 24-hour fluence started well below the Active threshold (1e8 integrated pfu) but steadily increased, reaching 6.28e7 integrated pfu at 22/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low activity is expected, with a continued risk of M-class flaring, mainly from AR3519 and AR3529.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are currently forecast. Earth has now left the previous high speed stream from coronal hole 82. A further high speed stream from coronal hole 83 is forecast to connect with the Earth today (22 Dec) with speeds estimated at 450-500km/s. These are then likely to wane during day 3 (24th Dec). Geomagnetic activity is expected to remain largely Quiet to Unsettled (Kp 0-3) during the period. There is a chance of Active (Kp 4) and a slight chance of a G1/Minor Storm (Kp 5) interval upon the uncertain connection to a high speed stream today.

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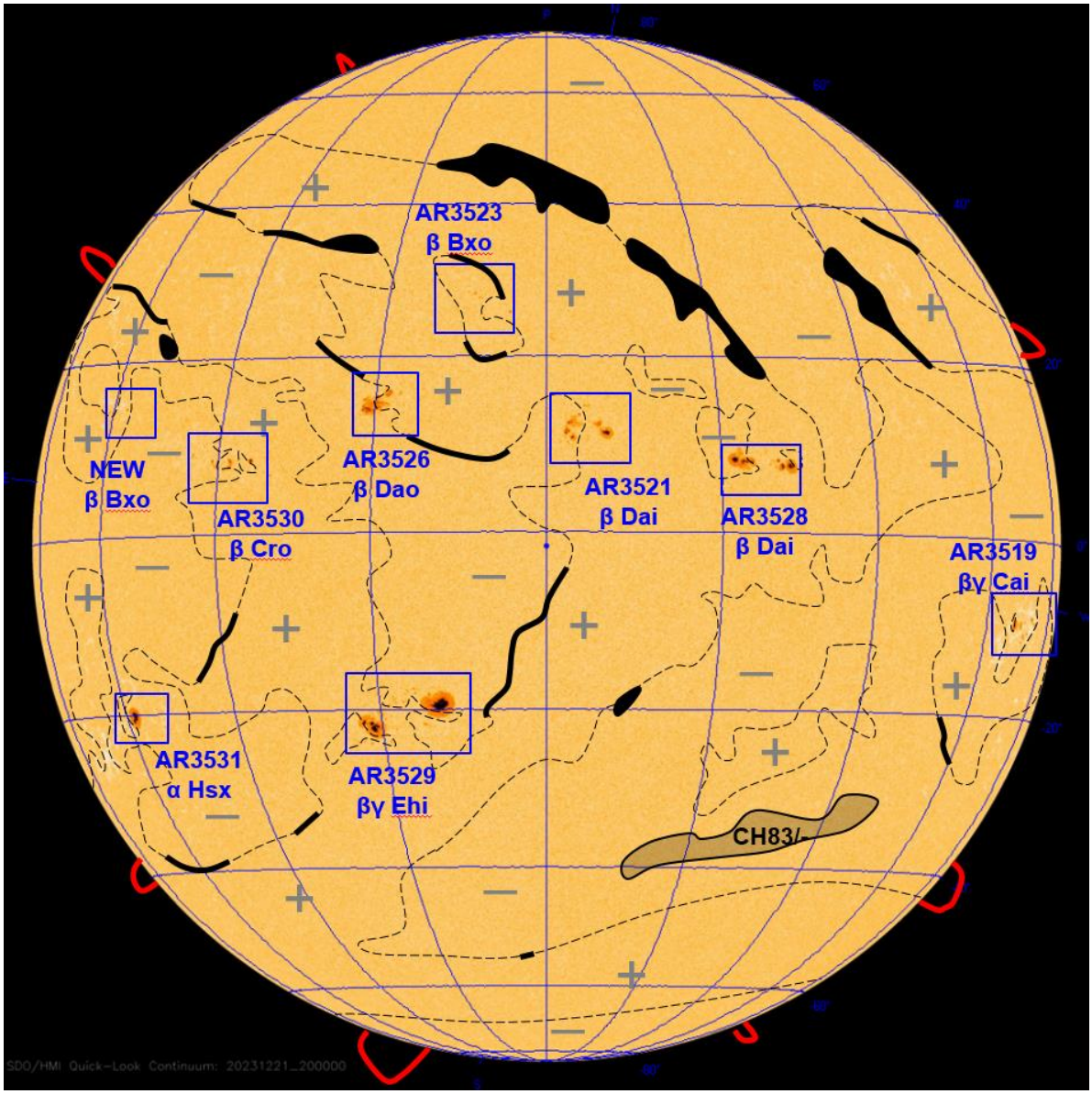
Energetic Particles / Solar Radiation: GOES16 high energy proton flux is at Background levels and expected to remain at similar levels. High energy electron flux is expected to remain close to or just above the high threshold (1000 pfu) at first. Flux levels may reach more persistently high levels later in the period, with a potential period in-between of temporarily falling to low to moderate levels if any weak geomagnetic activity occurs in association with the HSS from CH83. The associated electron fluence may approach the Active threshold today and again later in the period, but is considered unlikely to reach Active levels.

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME generated by the first M-class flare from AR3519 early on 21 December has been analysed and is not expected to be Earth-directed. Therefore no Earth-directed CME's feature in the forecast.
The solar wind is currently at background levels, having left the previous high speed stream from CH82. The high speed stream from coronal hole 83 may then connect with the Earth today (22 Dec), but this feature is quite a way south and appears weak in imagery. Therefore any connection is uncertain and likely to be weak, with solar speeds potentially reaching 450-500km/s before declining again through day 3 (24th Dec).

Geomagnetic activity is expected to remain largely Quiet to Unsettled (Kp 0-3) during the period. There is a chance of Active (Kp 4) and a slight chance of a G1/Minor Storm (Kp 5) interval upon the uncertain connection to a high speed stream today.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Radio Blackouts - X-Ray Flares:

There are nine regions on the visible disc. A new region in the northeast has also been classified, but as yet is unnumbered. AR3529 remains the most dominant region in the disc, and is currently classified at Ehi/beta-gamma. AR3528 is moderately large but relatively stable. The trailing portion of AR3521 has decayed slightly, although the lead portion has seen the proliferation of a number of small spots. AR3519 in the southwest has displayed minor decay, and is currently classified as Cai/beta-gamma but is becoming harder to analyse as it approaches the western limb. AR3530 has shown slight growth with an increase in intermediate spots. The remaining regions are all relatively small and magnetically simple with only minor growth or decay observed.
There is an ongoing chance of isolated M-class flares, mainly from AR3519 or AR3529. As AR3519 is currently the most active region and contributes significantly to flare probabilities, and the region will rotate off behind the southwestern limb later in the forecast period, so the probability of M-class flares decreases slightly from day 3.

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X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

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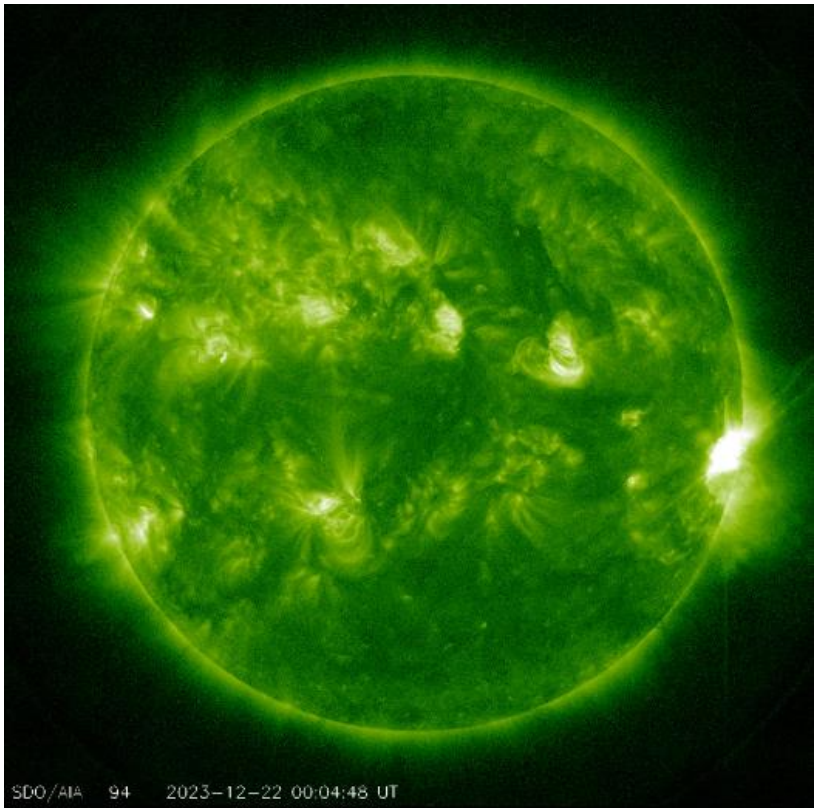
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: Latest SDO/AIA 94 image showing the latest M-class flare from AR3519 near the southwest limb.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is at normal background levels and is most likely to remain at similar levels. However, there is a slight chance of minor solar radiation storms throughout, initially from AR3519 before it rotates behind the southwest limb, but also from the regions currently in the eastern hemisphere as they rotate into a more geo-effective position.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux is expected to remain close to or just above the high threshold (1000 pfu) at first and again later in the period, with a potential period in-between of the flux temporarily falling to low to moderate levels. This will occur if any weak geomagnetic activity occurs in association with the HSS from CH83, and so suppressing the electron count in the radiation belts.
The associated electron fluence may approach the Active threshold today and again later in the period, but is considered unlikely to reach Active levels. The Met Office REFM model is currently underestimating the fluence, although it does show a continued rising trend for today followed by a decrease in fluence during days 2 and 3 which is accepted.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	50	20	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Met Office REFM model.

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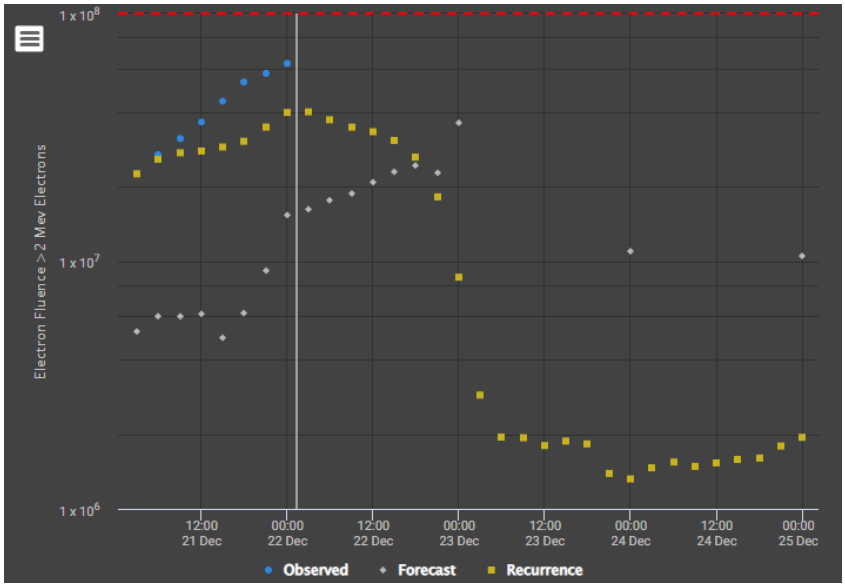

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